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Humane slaughter: an achievable goal?

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INTRODUCTION

Slaughter is a word deeply shrouded in emotion, a concept seemingly diametrically opposed to that of humane-ness. Yet pragmatically, survival is dependent upon large scale slaughter of other species.

Within modern society most of us are now divorced from this biological constraint of a direct predator role and most people in Western Civilisation will go through their life without the need to kill a mammalian species (except possibly mice). With the luxury of obtainable resources and availability of time that once would have been spent on the grind of obtaining adequate food, we can now devote time to philosophical issues such as humaneness in our interspecies relationships, unfortunately with sometimes tenuous and anthropocentric based conclusions.

Despite dietary fads, the majority of us obtain our protein requirement from the meat of vertebrate animals and probably will continue to do so. This makes it of necessity that sentient animals do not suffer during slaughter procedures. From a moral perspective a humane philosophy demands that an animal receives welfare consideration during all phases of its life. From an economic point of view such humaneness is also of considerable value, as the EEC as a whole, and the market consumer as an individual, demands a certain standard of treatment in order for a final product to be accredited.

Electrical preslaughter stunning may provide one means of reliably and quantifiably assuring humaneness of subsequent slaughter procedures. Electrical stunning can be head-only, in which case an electrical current is passed through the head inducing the stun and a subsequent slaughter method (such as throat cutting) is employed. Head-to-body stunning is also in practice, where the head current (the stun) is followed by a head-to-body current which slaughters the animal by stopping the heart.

The goal of a humane stunning system must be to assure that an animal, prior to slaughter, is 'unconscious' and 'analgesic' to subsequent slaughter. However, concepts such as 'insensibility' and 'unconscious' are very much prescientific with multiple, inconsistent meanings containing many disparate elements. If we examine the effects of dissociative anaesthetics (senses intact but loss of ability to form them into a coherent picture with resultant loss of perception of pain or anxiety), such as *Ketamine* (2- σ -chlorophenyl-2-methylamino-cyclohexanone hydrochloride) perhaps it is more important that the animal following stunning cannot form a coherent

mental construct of its external world (a requirement that seems necessary for perception of pain or anxiety).

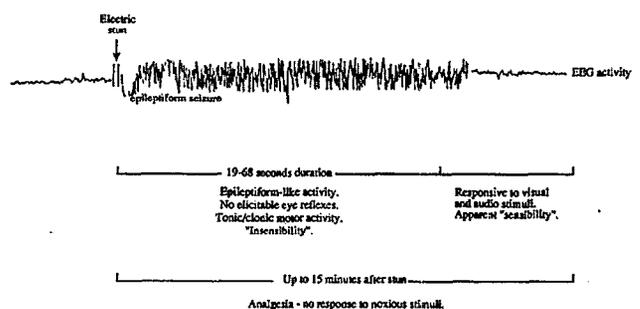
In neurophysiological terms 'consciousness' appears dependent upon the simultaneous, cooperative activity of many millions of neurones spread diffusely through the brain. A coherence of global function is required for a mental construct to be formed.

'Humane' quantification of preslaughter stunning

If the effects of a stun are to be quantified in a manner that meets the demands of an export market we must understand what a stun does to an animal's physiology.

It is possible to obtain a global overview of the activity in the brain's neurones by examining the electrical signals that are associated with this activity. The electrical signals can be measured from small electrodes positioned on the scalp of the animal - a process known as electroencephalography (EEG). Following a head-only stun, the magnitude and the frequency of the brain's electrical signals increases greatly. The EEG pattern (Figure 1) is similar to that seen during human Grand Mal epileptic seizures. In cattle and sheep this period of epilepsy lasts between 19 and 68 seconds after a stun. In deer this period appears lengthened and is between 60 and 120 seconds.

FIGURE 1: Typical type of electrical activity recorded (electroencephalogram) from an animal following a stun and the physiological events that take place following a head-only stun without subsequent slaughter.



Neurophysiologically these large amplitude high frequency spikes, the synchronous discharge of the epileptic seizure, are incompatible with a coherence of brain function that is needed to form a meaningful mental construct. Together with anecdotal studies of human epilepsy, and accepting the limits of current paradigms of consciousness, it is likely that during the period of seizure, following electrical

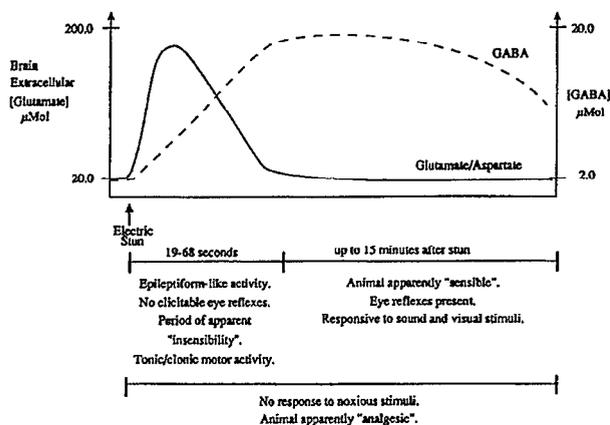
stun, the orderly brain functioning that mediates conscious mental constructs is precluded. Given that this is the case the stunned animal is thus unconscious and humane slaughter can take place.

The physiological effects of an electric stun are mediated by neurotransmitters in the brain. Immediately on delivery of a stun the release, and therefore the effect, of two excitatory neurotransmitters glutamate and aspartate is greatly increased. During normal brain functioning these two neurotransmitters contribute to such diverse functions as arousal, learning, memory, sexual activity and respiration. However, at the levels released following a stun the result is an "overexcitation" of the brain's neurones, a state which produces the epileptic-like seizure.

Administering drugs, prior to electrical stunning, that pharmacologically antagonise the action of glutamate/aspartate at their receptors produces a dose dependent reduction and eventual abolishment of the seizure state produced by stunning. This observation confirms the role of glutamate and aspartate in inducing the seizure state that follows stunning.

Another important physiological change also follows head-only stunning. If the animal is allowed to recover, a period of apparent analgesia is observed. This is not due to motor paralysis as motor movement can be elicited, nor is it due to dissociation as the animal demonstrates a volitional response of head movement towards sound. The analgesia lasts for between 5 and 15 minutes after stunning. This analgesia is also apparent in animals that have been pretreated with drugs that block the glutamate/aspartate receptors suggesting a separate mechanism to that responsible for the epileptic-like seizure (Figure 2).

FIGURE 2: A schematic representation of changes in extracellular brain transmitters and reflexes following a head-only electric stun.



The release profile of an inhibitory neurotransmitter γ -amino-4-butyric acid (GABA) mirrors that of the analgesic state. Pretreatment with drugs that antagonise at GABA receptors reduce and abolish post stun analgesia in a dose dependent manner.

In summary there are at least two quantifiable measures of the efficacy of head-only electrical stunning. The first, and of undisputable importance, is the presence of the epileptic-like seizure mediated by the neurotransmitters glutamate and

aspartate. The second, and of more arguable importance, is the period of post stun analgesia, mediated by the neurotransmitter GABA. This analgesia may not be necessary for a humane stun but does provide an adjuvant to the overall welfare of the animal.

As mentioned, with the head-only stun, this analgesic response is associated with normal motor and probable volitional responses thus highly indicative of a true analgesia. If, however, the head-only stun is delivered too far down the neck (cervical vertebra number six or below in the sheep) then motor paralysis is observed for up to 10 minutes after the stun. The presence of a seizure is also variable and this type of stun cannot be regarded as humane. To ensure humane-ness an adequate current must pass through the brain of the animal.

Vertebral arteries and head-only stunning

Ground breaking work by Blackmore's group (Newhook and Blackmore, 1982) in the early 1980's indicated that in calves and adult cattle where transverse throat cut left the vertebral arteries intact, blood flow to the brain continued for some time after the throat cut, prolonging the period of consciousness for between 45 and 85 seconds in a non-stunned animal following throat cut. Theoretically any animal with adequate vertebral artery supply to the brain could thus experience a period of prolonged consciousness following throat cutting.

In cattle allowed to recover (i.e. no throat cut) from head-only stunning the period of seizure lasts from approximately 30 to 65 seconds. Conceivably this could leave a margin of up to 20-30 seconds in which the animal was not protected by the "unconsciousness" of electrical stunning. However, this does not appear to be the case according to the experiments of Devine's group (Bager *et al.*, 1992) in which stunned and throat cut calves showed no return to consciousness after the epileptic seizure ceased at approximately 40-45 seconds.

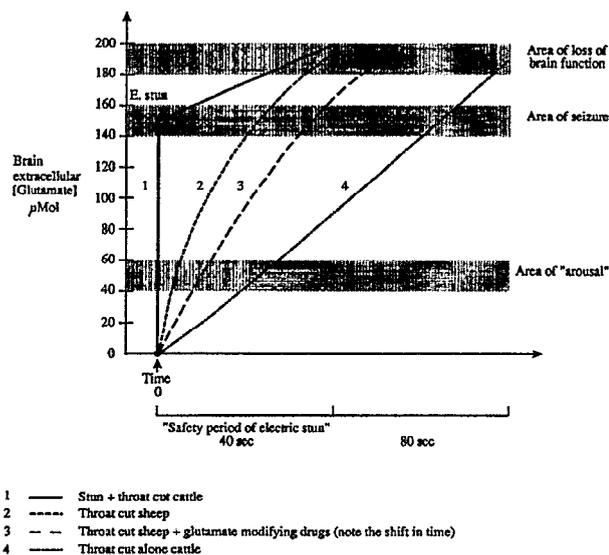
At first appraisal these two observations appear irreconcilable, however, that is not the case. Blackmore's observations were made on non-stunned animals while Devine's were only on stunned animals. New data examining brain neurotransmitter changes suggests that both groups are correct in their respective observations. Non-stunned cattle do appear to have a prolonged period of consciousness following throat cut and electrically stunned animals do not recover consciousness when the stun is combined with a throat cut. The throat cut and the electrical stun have a synergistic effect on particular brain neurotransmitters that produces a maintained state of unconsciousness.

As stated earlier, electrical stunning causes an initial massive release of the neurotransmitters glutamate and aspartate. At these levels a seizure state results. At lower levels glutamate and aspartate cause a general animal arousal, while at higher levels these neurotransmitters are associated with an irreversible loss of function, and accompanying loss of consciousness, and metabolic related death.

When an animal receives a throat cut the first level of response is a release of glutamate/aspartate to increase general arousal, as the metabolic insult intensifies so does the

glutamate/aspartate response until seizure states occur. This is then followed by irreversible loss of brain function and brain cell death. The time course of this sequence of events is dependent upon the supply (or lack of) oxygenated blood to the brain. In sheep where the vertebral artery supply to the brain is negligible the time to loss of consciousness following a throat cut is considerably extended by pretreating the animal with drugs that block the action of glutamate and aspartate.

FIGURE 3: Changes in brain extracellular glutamate levels in animals receiving a throat cut preceded by an electrical head-only stun. The safety period of an electrical stun is given as 40 seconds with the humane aim being to have moved the animal into the area of loss of brain function before this 40 second safety net period of seizure is complete.



Electrical stunning increases the levels of glutamate/aspartate to those favouring a seizure state in an extremely short period of time and the throat cut induced metabolic changes then adds cumulatively to this, moving the animal into the area of irreversible loss of brain function in a shorter time period than throat cut alone achieves (Figure 3).

Thus, by serendipity rather than planning, the combination of throat cut and head-only electrical stunning provides a synergistic safety net to assure humane slaughter.

SUMMARY

Preslaughter stunning is one area within the meat industry in which animal welfare has received considerable scientific scrutiny. As a result of this scientific approach a quality assurance of humaneness can be achieved.

While slaughter will probably continue to be an emotive issue it can at least be achieved in an humane and ethical manner by the use of appropriate preslaughter stunning. An animal's right to humane treatment can be successfully melded with pragmatic management and marketing of animal products.

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